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PROJECT MANAGEMENT: A NEW DIMENSION IN COMPLEX TASK MANAGEMENT

WORKING PAPER NO. 9

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The studies incorporated in the project management research series are supported by a grant from the National Aeronautics and Space Administration to Syracuse University. They are prepared by professors and graduate students from the following fields: business administration, engineering, political science and sociology. The studies are related to an investigation of project management and management systems associated with the Apollo program.

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INTRODUCTION

The objective of this paper is to present an overview of the project management concept as it is most commonly practiced in government and industry. It makes clear that project management is a relatively new management philosophy and is an alternative to traditional administrative methods. The paper should serve as a basic guide to individuals interested in furthering their understanding of this management concept. Several of the most significant topics associated with project management will be examined in the subsequent sections of the paper. These include the following:

1. The philosophy and rationale of project management.
2. Definitions of key project management concepts.
3. Criteria for using project management
4. The institutional/functional/programmatic interfaces of the project organization.
5. Advantages of project management organization.
6. Types or models of project management organization.
7. Managerial strategies used in the project environment.

An effort is made throughout to present both the key structural aspects of project management, the mechanical side of organizing for it, as well as the behavioral dimensions of the project management system.

PROJECT MANAGEMENT: A PHILOSOPHY AND RATIONALE

Due to the demands of complex, technological undertakings, several unique management methodologies have emerged in recent years. These methodologies have been responsible for several evolutionary processes in both industrial administration and in public administration.

Although the term project management or program management is frequently employed as a single, concrete management methodology it is not. The construction and terminology of project management has impeded the understanding of it by those not closely associated with it. Project management or as it is sometimes called, program management, may refer to several new approaches to management. Each approach is designed to increase the effectiveness of managing complex organizational tasks.

With the increasing task complexity and technology it became evident that traditional methods of organization were not always adequate. Depending in part, upon the structure of an organization, problems often occurred when it was necessary to integrate systematically and colaterally several of its functional areas -- especially when an organization attempted to undertake the larger, more complex, and finite "projects" or "programs".

Part of the problems inherent in mobilizing the resources in a functionally oriented and dominated organization can be explained, in part, by looking at the canons of traditional methods of organization. The most prevalent tenets can be delineated below:

A. Organizations function as an integrated entity on a vertical basis.

B. A strong superior - subordinate relationship is required to preserve unity of command and to insure unanimity of objective.

C. Individual functional managers are parochial (and rightly so).

D. Functional managers maintain lateral staff coordination to obtain integrated staff action.

E. Organizational groups have a basic dichotomy, viz., line and staff.

F. A scalar chain of authority relationships exist within the organization, ranging from the ultimate authority to the lowest rank, with the line of authority following every link of the chain.

G. An employee should receive orders from one superior only.

H. Work progresses among relatively autonomous functional units of an organization.[1]

This paper does not imply that "functionalism" as found in traditional approaches to organization is without benefit. Functionally oriented structures contain many inherent advantages. A researcher described some of the benefits as follows:

> The strengths of the functional organization are rather apparent. There is an opportunity for the professional growth and interchange of knowledge among individuals of similar interests and training. The functional organization is able to justify programs which task-oriented organizations cannot. There is opportunity for advancement in the functional organization's line structure within a narrow band of professional knowledge. It is more likely that more competent personnel can be recruited since there is a depth of knowledge and experience in the functional component against which to measure applicants. Some efficiencies are possible since it is often feasible to assign one man to several and to supervise him effectively. Finally, there are some psychological benefits to the individual who feels he belongs in a group in which he knows where he stands.[2]

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[1]David I. Cleland and David C. Dellinger, "Changing Patterns in Management Theory," Aerospace Management, Spring, 1966, p. 3.

[2]R. J. Betterton, Program Management in a Non-Defense Industry Environment. Unpublished Paper, College of Business Administration, Syracuse University, April, 1968.

Although there are advantages of the functionally oriented organization, some disadvantages occur which affect an organization's ability to manage large and multidisciplined ventures. The functional approach, for example, often makes the task of mobilizing diverse organizational resources difficult and cumbersome. Some undertakings, for example, require the simultaneous contributions of professionals and technicians in several functional areas of the organization. Without some type of coordination mechanism with the appropriate organizational charter it is difficult to bring diverse inputs together and have them perform as a team. Why? The ecological framework for functionally oriented organizations is conducive to the breeding and maintenance of "power centers". As one author noted, "it is a boon to empire builders". Perhaps the comment by Stahel Edwards can best describe the limitations of the functional organization. He notes the following:

> The sad part is that the functional organization has been hopelessly outdated by a large scale, technical world. There is no reasonable way that a huge pyramid of people can talk to each other all at once, and there is no way that they can work together if they do not. . .
>
> The real hope of strengthening and quickening the large corporation would seem to be in looking at the enterprise as a flow of inter-related actions rather than a cluster of semi-autonomous functions. A functional organization represents a formal division of the enterprise into domains whose only access is through channels. A possible alternative is an action-centered organization that is more casual and loose, with open access from any direction; indeed, it would coincide with the informal organization that already exists in any company.[3]

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[3]"The Reach of an Executive," Harvard Business Review, January - February, 1959.

In addition to the "natural limitations" of functionally-oriented organizations other forces have influenced the behavior of organizations and organizational participants. Schull, et al., allude that there are a number of socio-economic, psychological, technological and cultural forces at work which are requiring a reorientation of organization theory. The following have been mentioned as variables influencing organizations:

1. The western tradition of fragmented power which has diluted the legitimacy of the hierarchial positions.

2. An emphasis on expertise and achieved status, as opposed to charisma and positional status.

3. Rise of the "scientific ethic," with its propensity toward evolution and change, including modification of conservative social institutions.

4. The knowledge explosion, making omniscience anachronistic and creating an imbalance between hierarchical authority and instrumental competence.

5. The impact of educated and mobile professional and technical personnel on organizational systems, including expertise and collaboration in decisions affecting working relationships.

6. The changed nature of transactional behavior and organizational goals, resulting in more complex technologies, whether programmed or unprogrammed.[4]

Such forces as these have caused management and organization theorists to re-examine our traditional management approaches.

Bennis has examined the weaknesses of traditional organizations and has forecasted the decline of bureaucracy as the prevalent organi-

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[4]André L. Delbecq, Fremont A. Schull and Alan C. Filley, "Matrix Organization. . . .An Evolution Beyond Bureaucracy." Unpublished paper, not dated.

zational model. His "prediction" was based on the evolutionary principle that every age develops an organizational form appropriate to its genius, and that the prevailing form today - the pyramidal, centralized, functionally specialized, impersonal mechanism known as bureaucracy - was out of joint with contemporary realities."[5]

In an attempt to mentally simulate the futuristic organizational model, Bennis noted the following:

> Organizations of the future. . .will have some unique characteristics. They will be adaptive, rapidly changing temporary systems, organized around problems to be solved by groups of relative strangers with diverse professional skills. The group will be arranged on organic rather than mechanical models; they will evolve in response to problems rather than to programmed expectations. People will be evaluated, not in a rigid vertical hierarchy according to rank and status, but flexibility according to competence. Organizational charts will consist of project groups rather than stratified functional groups, as is now the case. Adoptive, problem-solving, temporary systems of diverse specialists, linked together by coordinating executives in an organic flux - this is the organizational form that will gradually replace bureaucracy.[6]

Bennis makes clear that the dramatic changes he predicted a short time ago are now becoming a reality in several organizations concerned with advanced technologies. One of the major problems he foresees with the advent of the new organizational models is how they will be managed. He maintains that understanding the "leadership requirements" of these new organizations is crucial for future development of management theory.

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[5] Warren G. Bennis, "Post-Bureaucratic Leadership" Trans-Action. July - August, 1969, p. 44.

[6] Warren G. Bennis, Ibid, p. 45.

Due to these deficiencies in the bureaucratic model of organization, project management has been developed into a unique management methodology with the potential of creating a more flexible organizational response to management challenges.

Before proceeding a few key definitions will be explained to aid in understanding some of the basic project management terminology.

DEFINITION OF KEY TERMS

A. Project -- A "set" of interrelated activities necessary to accomplish specific mission objectives. It is generally associated with the development of an integrated unit of hardware.

B. Program -- "Sets" of interrelated activities. A program is normally considered as being composed of several "projects". The sum of the projects equals a program undertaking.

C. Project Manager -- The executive or manager responsible for a defined "set" of interrelated activities.

D. Program Manager -- The executive in charge of coordinating "sets" or groupings of interrelated activities.

E. Functional Manager -- Manager in charge or working with an established, on-going activity within the organization's institutional structure.

To refine our definitional constructs we might add these dimensions at this point. Perhaps the following explanations of project management will help us understand conceptually the total rationale and philosophy of project management. Project management thus can be described as:

A. A philosophy of organizational operation.

B. A managerial tool.

C. A focal point of an organized but fluid social system.

D. A hub of a mechanical system.

E. A management approach which violates in a positive manner many of the basic tenets of classical bureaucratic design.

CRITERIA FOR USING PROJECT MANAGEMENT

There has been considerable discussion on when an organization should utilize project management. Although there are no uniform guidelines, researchers have indicated that its use is warranted when the following characteristics are present in a task.

1. Project Scope: Project management can be profitably applied as a rule, to a one-time undertaking that is (1) definable in terms of a single, specific end result, (2) bigger than the organization had previously undertaken successfully. A project must, by definition, end at an objective point in time. . .[7]

2. Unfamiliarity: An undertaking is not a project, in our sense of the term, unless it is a unique, or infrequent, effort by the existing management group. Lack of familiarity or lack of precedent usually leads to disagreement or uncertainty as to how the undertaking should be managed. In such a situation, people at the lower management levels need to be told precisely what they are to do, while senior executives are justifiably troubled by a greater than usual sense of uncertainty about the realism of initial cost estimates, time commitments or both.[8]

3. Complexity: Frequently the decisive criterion of a project is the degree of interdependence among tasks. If a given task depends on the completion of other assignments in other functional areas, and if it will, in turn, affect the cost or timing of subsequent tasks, project management is probably called for.[9]

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[7] John M. Stewart, "Making Project Management Work," Business Horizons Fall, 1965. p. 56-57.

[8] John M. Stewart, Ibid, p. 57.

[9] John M. Stewart, Ibid, p. 58.

4. Stake: A final criterion that may tip the scales in favor of project management is the company's stake in the outcome of the undertaking. Would failure to complete the job on schedule or within the budget entail serious penalties for the company? If so, the case for project management is strong.[10]

In essence, the criteria for utilizing project management depends greatly upon the complexity of the project; the degree of unfamiliarity with the problems involved; the importance placed on mobilizing critical organizational resources; and the degree of control necessary to manage the project's cost, schedule and performance objectives. These criteria do not necessarily limit project management to the one-time large undertaking. It can also be used in the more routinized ventures.

INSTITUTIONAL/FUNCTIONAL/PROGRAMMATIC INTERFACES

To further delineate some of the primary differences between the traditional management approaches and the project management approaches, the interrelationships that exist among an organization's institutional structure, functional structure, and the programmatic or project structure must be delineated. The former provides the broad "umbrella" in which the functional and programmatic organizations operate. Traditionally it has provided the mechanism and framework for coordinating the various specialized departments (functional departments) and the various staff positions supporting the functional areas. As illustrated in Figure 1 the institutional

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[10] John M. Stewart, Ibid, p. 58-59.

organization is responsible for formulating the policies of the organization; maintaining the necessary resource base; and defining the missions it wishes to undertake as an organizational entity.

The programmatic organization finds its ecological base within the institutional structure and receives the necessary professional and technical inputs from the functional organization. The functional organization can be described as a "store-house" of expertise from which the project organization draws as required.

The working relationship between the functional organization and the project organization may be well-defined or vaguely defined depending upon the charter top management establishes for the project. Conceptually, project management can be described as a "free-floating" management system operating across ,and drawing upon ,the inputs of various functional departments as they are needed.

Thus, the programmatic organization encompasses the project manager, his staff and the interaction patterns between the project manager and other functional areas within the organization. Specifically, it is the organizational environment in which the project manager accomplishes his task objectives. Regardless of the size or complexity of a given project both the institutional and functional organizations are always present. As will be explored in a later section, it will be shown that the particular "model" of project management used determines the interfacing patterns of the programmatic organization to the functional and to the institutional organizational structure.

To illustrate the differences and relationships between the project organization and the functional organization one researcher has constructed the following framework (presented in Table 1) that compares several organization concepts from a project and a functional perspective.

Institutional/Functional/Programmatic Interfaces

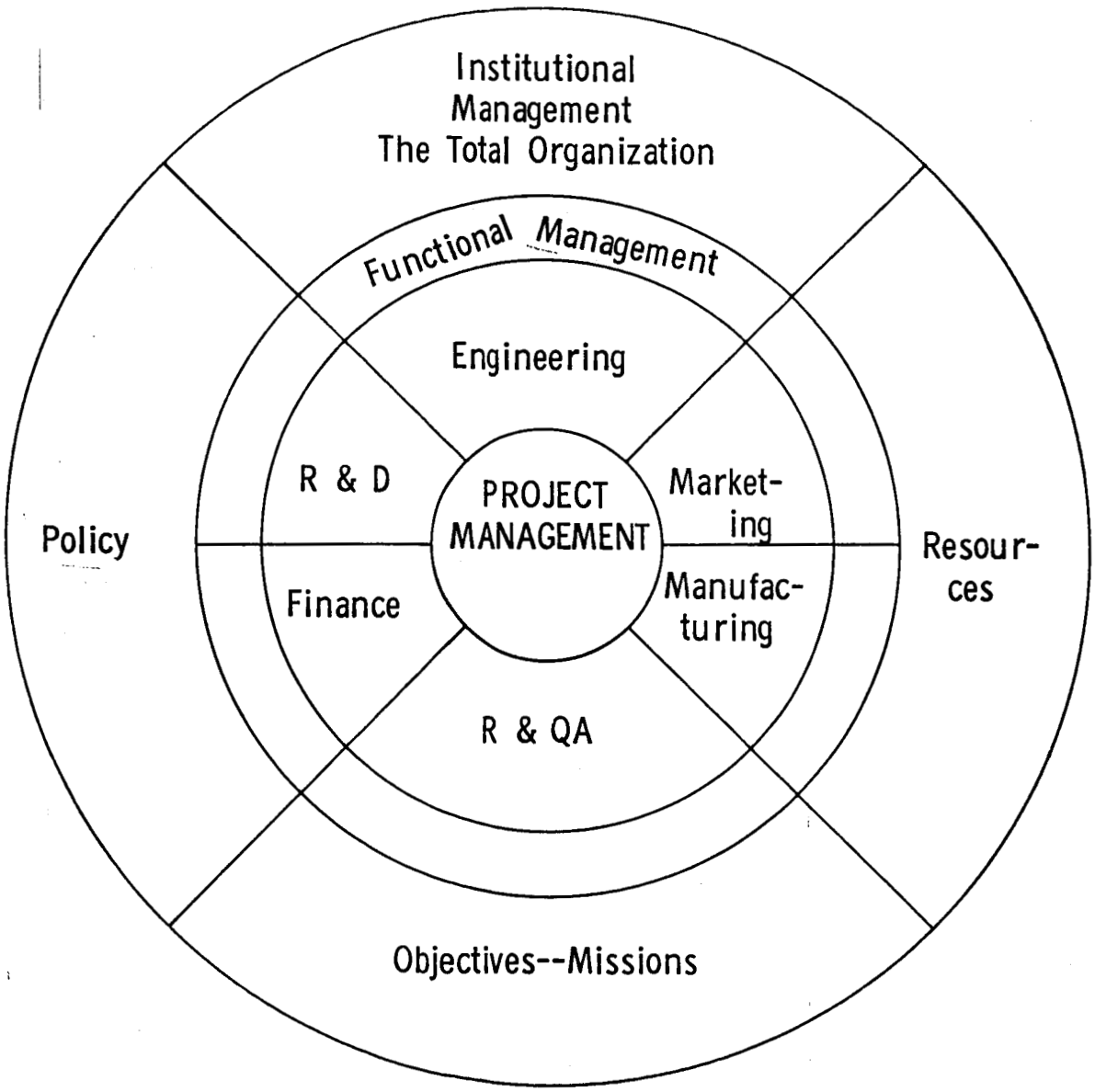

FIGURE 1

Table 1

Comparison of Specific Organizational Concepts from the Project Viewpoint and the Functional Viewpoint.

Phenomenon	Project Viewpoint	Functional Viewpoint
Line-Staff Organizational Dichotomy	Vestiges of the hierarchial model remain, but line functions are placed in a support position. A web of authority and responsibility relationships exist.	Line functions have direct responsibility for accomplishing the objectives; line commands, staff advises.
Scalar Principle	Elements of the vertical chain exist, but prime emphasis is placed on horizontal and diagonal work flow. Important business is conducted as the legitimacy of the task requires.	The chain of authority relationships is from superior to subordinate throughout the organization. Central, crucial and important business is conducted up and down the vertical hierarchy.
Superior-Subordinate Relationship	Peer-to-peer, manager-to-technical expert, associate-to-associate, etc. relationships are used to conduct much of the salient business.	This is the most important relationship; if kept healthy, success will follow. All important business is conducted through a pyramiding structure of superiors to subordinates.

Phenomenon	Project Viewpoint	Functional Viewpoint
Organizational Objectives	Management of a project becomes a "joint venture" of many relatively independent organizations. Thus the objective becomes multilateral.	Organizational objectives are sought by the parent unit (an assembly of suborganizations) working within its environment. The objective is unilateral.
Unity of Direction	The project manager manages across functional and organizational lines to accomplish a common inter-organizational objective.	The general manager acts as the one head for a group of activities having the same plan.
Parity of Authority & Responsibility	Considerable opportunity exists for the project manager's responsibility to exceed his authority. Support people are often responsible to other managers (functional) for pay, performance reports, promotions, etc.	Consistent with functional management; the integrity of the superior-subordinate relationship is maintained through functional authority and advisory staff services.
Time Duration	The Project (and hence the organization) is finite in duration.	Tends to perpetuate itself to provide continuing facilitative support.

Source: David I. Cleland, "Understanding Project Authority Requires Study of Its Environment," Aerospace Management, Spring/Summer 1967, p. 10.

The above chart compares different organizational concepts from the project manager's viewpoint and from the functional manager point-of-view. To delineate differences between the project manager's and the functional manager's responsibilities, Table 2 gives examples of both the functional and project responsibilities from a corporation in the aerospace industry.

Table 2

Comparison of Program and
Functional Manager's Responsibilities

Program Manager	Functional Manager
Program Direction	**Operational Direction**
Directs and controls company program and functional organization and subcontractor activity to achieve program objectives.	Determines who will perform detailed tasks, where they will be done, and how they are to be accomplished.
Develop Master Program Plans.	Provides a stable base for the development of talent and skills to assure the maintenance of technical capability.
Determine and issue the work breakdown structure and related work statements, budgets, and schedules which define what effort will be accomplished, who will have SDW accountability, and when it will be performed.	Provides necessary facilities and services to support program requirements.
Program Control	**Operational Control**
Monitors cost, schedule and technical results against master program plans.	Responsible for the technical excellence and quality requirements of assigned tasks.
Replaces and rebudgets as necessary to assure accomplishment of program objectives.	Assures that all tasks are accomplished in accordance with technical specifications, on schedule and within budget.

Configuration Management	Administration
Controls changes and assures configuration accountability affecting the program.	Performs administrative services in support of personnel assigned to a program. Initiates merit increases for all personnel within their organization. Approves the assignment and concurs in merit increases of key functional personnel assigned to the program.

Source: North American Aviation

The above example delineating the differences in responsibilities between program or project management and functional management only is used for illustration purposes. The demarcation between each one's responsibilities vary from organization to organization and again according to the project management model employed.

Perhaps the key to understanding the complex web of inter-relationships among the institutional, functional and programmatic organizations is to examine the basic rationale for this arrangement. We have alluded to several problems inherent in an institution, organized by functional divisions, when it undertakes complex tasks. At the same time, we illustrated the inherent "strengths" found in functionalism. Project management is a management system which attempts to limit the weaknesses found in functionally organized entities and capitalizes on functionalism's great strengths.

ORGANIZATIONAL ADVANTAGES OF PROJECT MANAGEMENT

In a preceding section of this paper, we discussed some of the differences between the traditional management approach and project management. Basically, these differences revolved around the difference in organization and philosophy. In the next few sections, a closer examination of these differences will be made in terms of how they affect the daily management operations.

Identification of Responsibility

The increased complexity of many organizational tasks has made it imperative for management to identify the appropriate responsibility areas for purposes of stringent management control. When a project venture requires the inputs of several departments or functional areas, systems for the identification of responsibilities must be established as well as systems of accountability. Conceptually speaking, the responsibility system lies with the functional divisions conducting the operations, while the accountability lies with the project manager.

Implementation of Management

Most projects because they are not "routine" undertakings require the employment of rather stringent control systems. Again, the project concept establishes the accountability for deviations from the project's planned performance objectives. Generally, three indices are utilized to plan and audit work performance in the project organization. These are the schedule objectives, budgetary or cost objectives, and the performance objectives.

The schedule objective is used in several ways. First, it helps measure how long a project or its sub-system components take to reach task completion. Program Evaluation and Review Techniques (PERT) frequently are used to integrate project components and measure system completion rates in terms of time.

Budgets or cost objectives also place parameters on the project manager and provide an additional benchmark by which the costs of the project and its components can be measured. When dual reporting systems are employed that measure both the time and cost of completing the various components of the project, then good indices of project performance at various completion stages can be formulated.

The following example illustrates the usage of various performance indices in project control. Project X was programmed for completion in 36 weeks at a cost of $150,000, however, actual project time expended was 42 weeks at an actual cost of $160,000.

Actual completion and budget indices would be 117 and 106, respectively, considering the original programmed time and budgets estimated at the base index of 100.

The third major project objective is the performance required from the project. Simply put, does the project perform according to the objectives established for it? In most cases, auditing performance requirements is more difficult than evaluating the commitments to time and budget objectives.

Systematic View of the Project

Closely allied to the preceding discussion of the identification of key responsibility areas, is top management's opportunity to view the project as an "action system". From an organizational perspective this allows the top management to survey the total performance of the project and its relationship to the institutional and functional parts of the organization. In addition it may offer the opportunity for efficient conflict resolution within the organization. Because of the stake involved in the project, management is in a better position to assure that a project receives broad organizational support.

Communication Flexibility

As in conducting any management task, a network of communication channels evolves - both formal and informal. The project management concept offers two primary advantages as far as communication channels

are concerned. First, if the project organization is established correctly, it can shorten the formal communication lines. This makes for greater flexibility and responsiveness in the project organization and top management. Directives from top management may be funneled directly to the project organization. Similarly, the project manager has direct communication channels to top management when problems need resolving. This arrangement offers speed, flexibility and minimal distortions of communications.

In addition to the formal communication channels, there are also the informal ones. These are usually established according to the problem areas that need resolution. These channels are established by the project manager and are used in the conduct of "getting the job done" and as sources of information and intelligence.

MODELS OF PROJECT ORGANIZATION

Numerous organizational designs have been devised to cope with complex management problems. From a project management perspective, these range in size from one manager to one that virtually involves everyone within the organization. Each model has its own unique characteristics, advantages and disadvantages. Further, each is designed to accomplish the particular objectives established for it.

For organizations not experienced in the use of project management techniques it is advisable to formulate the objectives of the project first and then select the organizational design which is

most effective in attaining the objectives of the project. Once the project objectives are established, and a basic surveillance of the organization's strengths, weaknesses and characteristics have been made, a decision can then be made as to the type of resources that are needed. In this case, resources refer to both the technical and human resources and the most effective means of managing those resources. For example, organization A is an industrial contractor in the aerospace industry. It has a contract for an advanced program (project X-Y). Although the project is not significantly large in terms of the dollars involved, it involves advanced technologies in one particular area, i.e., radar guidance systems. The decision by top management is made to locate the project organization within the advanced radar guidance systems division rather than having it as a semi-autonomous operating division. The rationale behind this decision was explained in terms of resource economies. It appeared more effective to place the particular project where the advanced radar system engineers and scientists were already doing their research -- where they had already established good working relationships. The project manager in this case was responsible for planning the project, mobilizing the required resources and controlling the progress of the task.

In the following paragraphs, several different models of project organizations will be identified and their unique characteristics

identified. Following the description of the models, generalizations about the behavioral problems of each model will be discussed.[11]

Internal Functional Model (Direct Authority)

This organizational arrangement is usually found within an existing functional department. Generally, the project manager is directly responsible for the part of the functional organization assigned to him. This arrangement gives a direct point of accountability for the project. One of its prime advantages is that it is usually located within a major functional division and can draw upon the resources of that division effectively. Providing the project manager has good relations with his superiors he can establish himself within the functional unit. If most of the major problems occur within the confines of the division discipline, this model is usually quite effective. Care, however, must be taken if the project requires inputs and contributions from several divisions. If the project requires diverse divisional inputs, then the project manager must build alliances, negotiate and make trade-offs with these divisions to secure the necessary resources.

An example of this model is illustrated in Figure 2.

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[11]For additional information on project management organizational models see: Allan Janger, "Anatomy of the Project Organization," Business Management Record. November, 1963, pp. 12-19; C. J. Middleton, "How to Set Up a Project Organization," Harvard Business Review March - April, 1967, pp. 73-82.

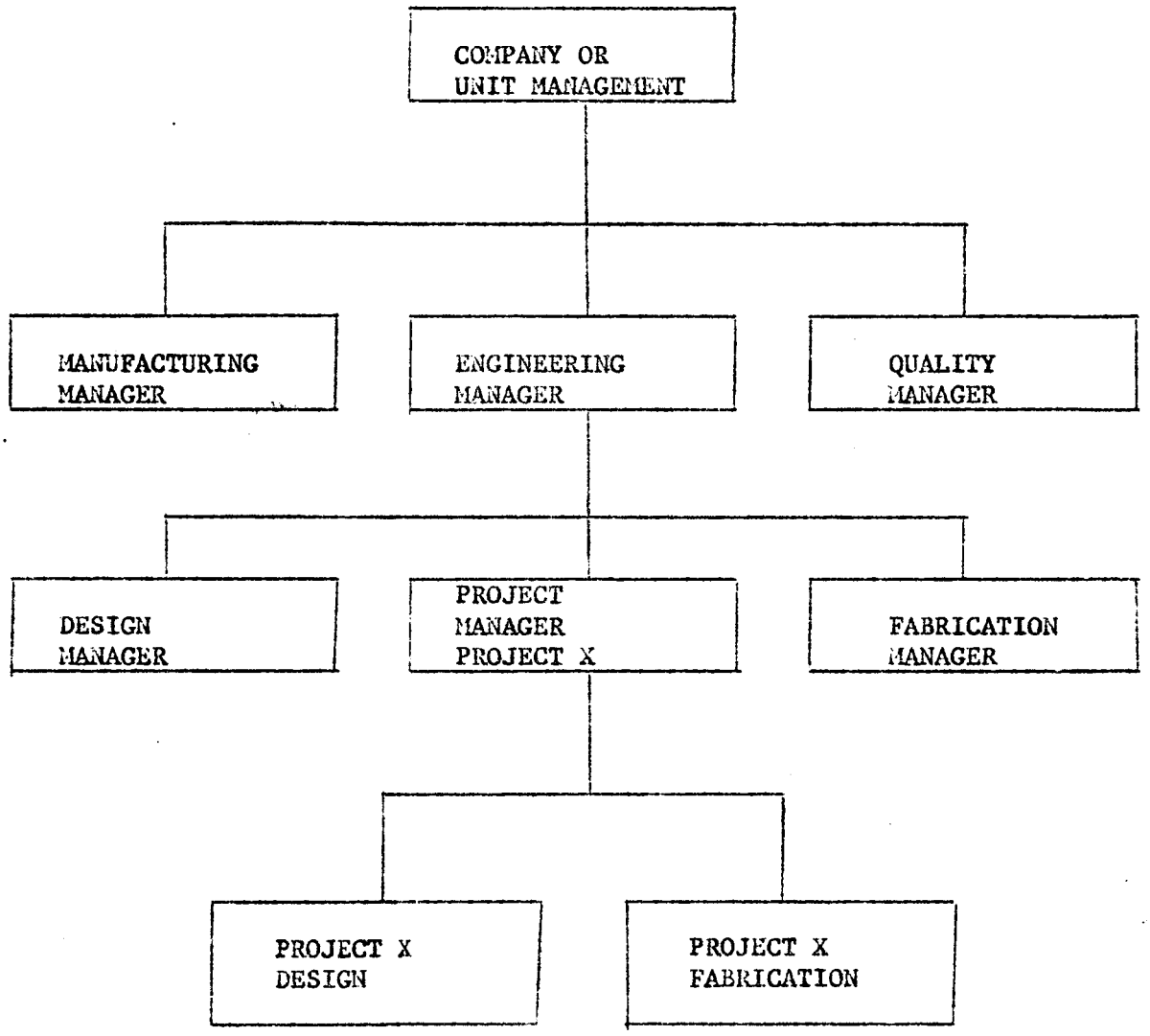

FIGURE 2 INTERNAL FUNCTIONAL MODEL
(DIRECT AUTHORITY)

SOURCE Allan Janger, "Anatomy of the Project Organization," Business Management Record November, 1963. p. 12. Used courtesy of the National Industrial Conference Board and Business Management Record. Figure titles are the author's.

Internal Functional Model (Indirect Authority)

The internal functional model with an indirect authority relationship to the project participants is similar in many respects to the previous models. The major similarity is that the project is again located within a major functional area of an organization. The project manager has "project authority" over the units performing work on the project, but not the usual type of "line" authority.

This particular model is frequently employed when it is desirable to establish direct responsibility for controlling the progress of the project. It allows the manager of the particular functional area to retain line control over the project, if and when needed. Problems occur in this model when conflicts develop between the manager of the functional area and the project manager. In one sense, the project participants report to two superiors using two different types of authority. It is imperative for the project manager in this case to establish good working relationships with his subordinates and superior.

The Internal Functional Model with indirect authority is illustrated in Figure 3.

Pan-Organizational Model

The third type of project organization is one where the project manager may have the authority to coordinate several functional areas. Normally, we see such an organization used for complex, large-scale undertakings which utilize inputs across the

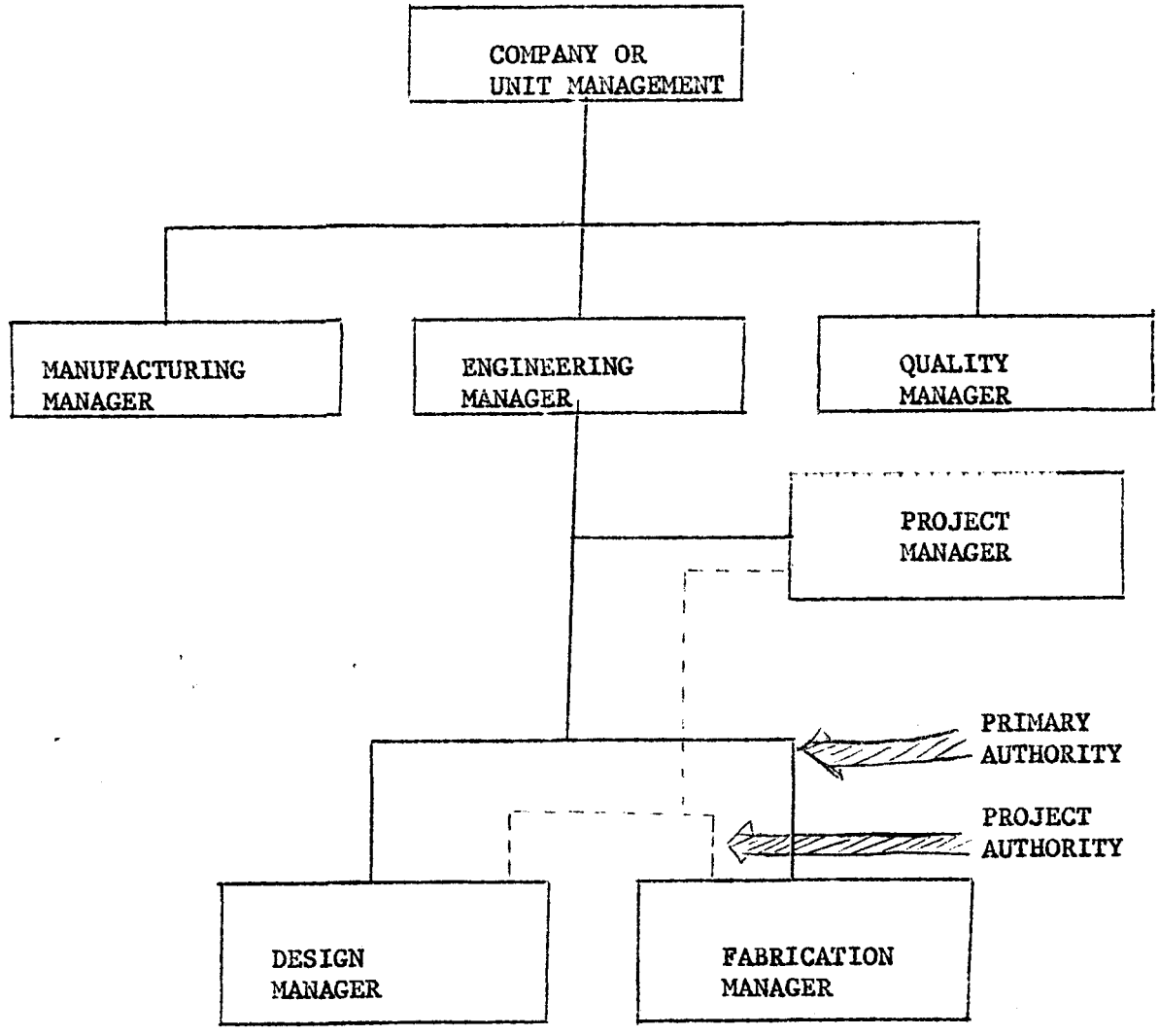

FIGURE 3 INTERNAL FUNCTIONAL MODEL
(INDIRECT AUTHORITY)

SOURCE Allan Janger, "Anatomy of the Project Organization," Business Management Record November, 1963. p. 13. Used courtesy of the National Industrial Conference Board and Business Management Record. Figure titles are the author's.

organization. In this model, depending upon the charter given the project manager, we see several potentials for conflict between the functional managers and the project managers. In general, the project manager needs a strong project "charter" to be effective in this situation. He must issue project directives to the project participants in each functional area and coordinate the participants in the various functional areas as they are needed. By placing the project manager at a high level, this will give him the organizational "leverage" to accomplish his tasks.

This model of project management is illustrated in Figure 4.

Program/Multi-Project Model

Another model of project management frequently found when an organization undergoes an extensive organization is called the program/multi-project model. The use of several "project managers" to coordinate each functional department's contribution to the project or program. This arrangement offers the opportunity for having someone within and familiar with the working relationships of the department coordinate the work performed on the project. The normal line of communication in this model is from the project manager of the total project to the department or functional project manager. This arrangement is likely to result in a high level of coordination for the total project.

Numerous areas for conflict are present in this model although it is widely used. For example: How much "power" should the project

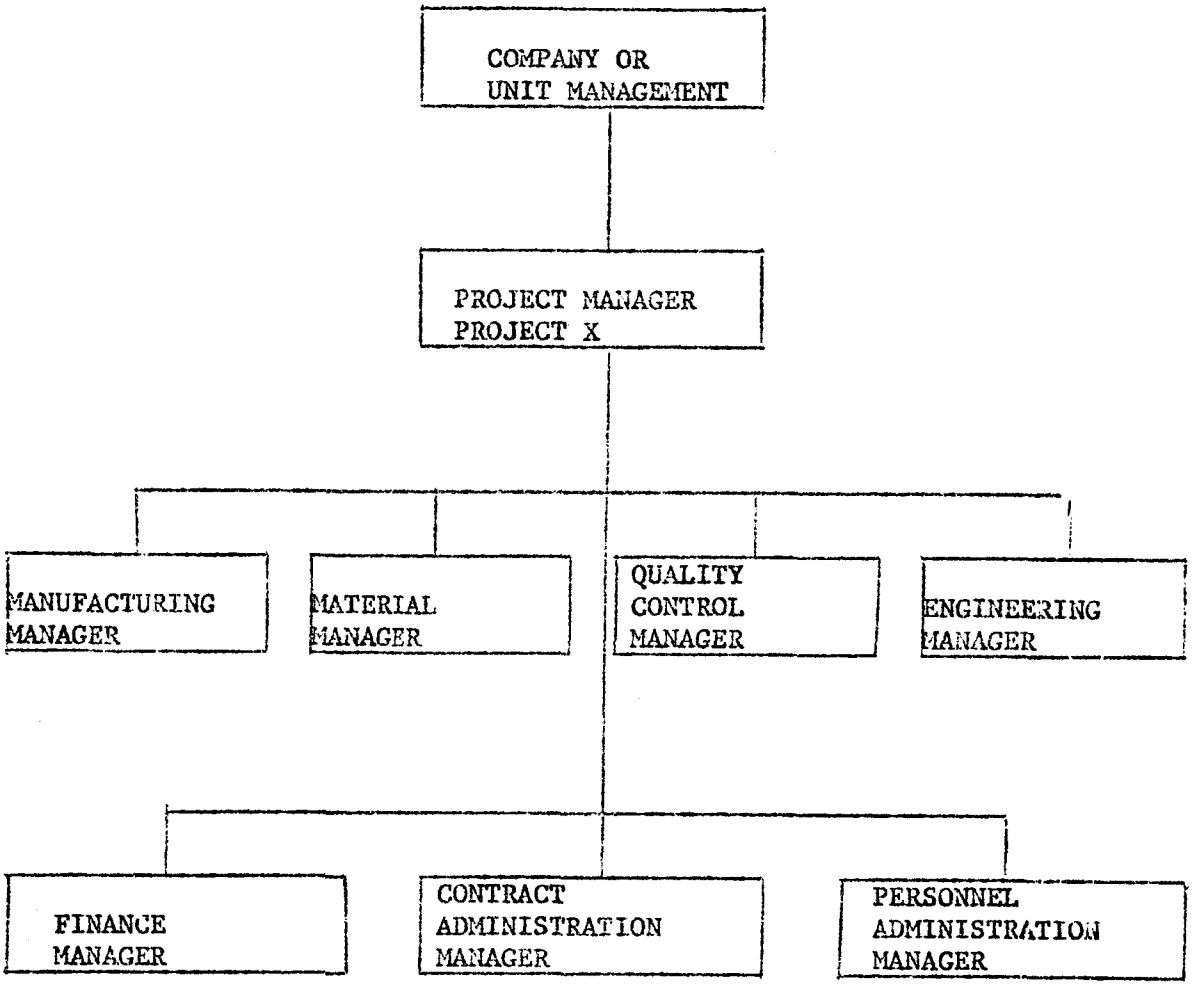

FIGURE 4 PAN-ORGANIZATIONAL MODEL

SOURCE Allan Janger, "Anatomy of the Project Organization," Business Management Record November, 1963. p. 13. Used courtesy of the National Industrial Conference Board and Business Management Record. Figure titles are the author's.

manager have? How much authority should be vested in the project manager? Is the project one of high or low priority as far as the organization's missions and objectives are concerned? What is the procedure for resolving conflicts that occur between the project manager and the functional departments? Questions such as these must be resolved prior to establishing this type of project organization.

The program/multi-project model is illustrated in Figure 5.

Apollo Project Management Model

Another type of project organization is utilized in NASA's Apollo Program. Although different variations of the Apollo model exist at other NASA field centers the most clearly delineated model is found at the Marshall Space Flight Center (MSFC) located at Huntsville, Alabama. Basically, two organizations within MSFC are responsible for the Apollo project which are the Industrial Operations Organization (IO) and the Research and Development Organization (R&DO). Each organization has been delineated a special and rather unique role to perform. Project managers within IO are accountable for the project and seeing to it that it meets the required cost, schedule and performance objectives established. The R&DO organization is utilized to provide maximum technical support to the various project managers and their subsystem managers. The project subsystem managers are responsible for a smaller hardware system and they interface with their R&DO counterparts in the

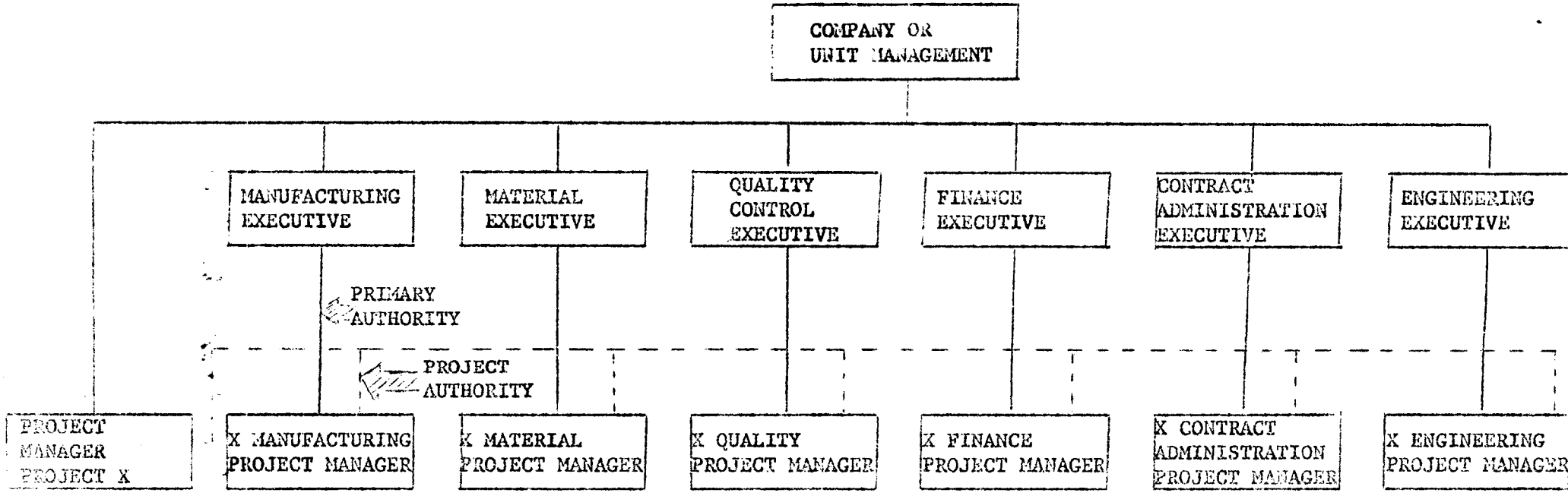

FIGURE 5 PROGRAM/MULTI-PROJECT ORGANIZATION

SOURCE Allan Janger, "Anatomy of the Project Organization," Business Management Record. November 1963, p. 14.
Used courtesy of the National Industrial Conference Board and Business Management Record. Figure titles and the author's.

laboratories and with the industrial contractor. This arrangement is designed to provide specialized management attention to each component system. Additionally, it provides a mechanism that tempers the weakness in any one organization (project management, R&DO, and the contractor). One can conceptualize the arrangement as one of "checks and balances". For example, the R&DO organization's primary responsibility is to insure technical performance. Dedication to technical perfection may inhibit the meeting of manufacturing and launch schedules and cause various problems with project costs and budgets. The industrial contractor may be primarily concerned with schedule, costs and profits. The project manager, on the other hand, may be concerned primarily with meeting various schedule deadlines. Each organization with its own primary objectives and its own way of viewing the project helps temper the demands of the other organizations.

The triad of relationships is illustrated in Figure 6.

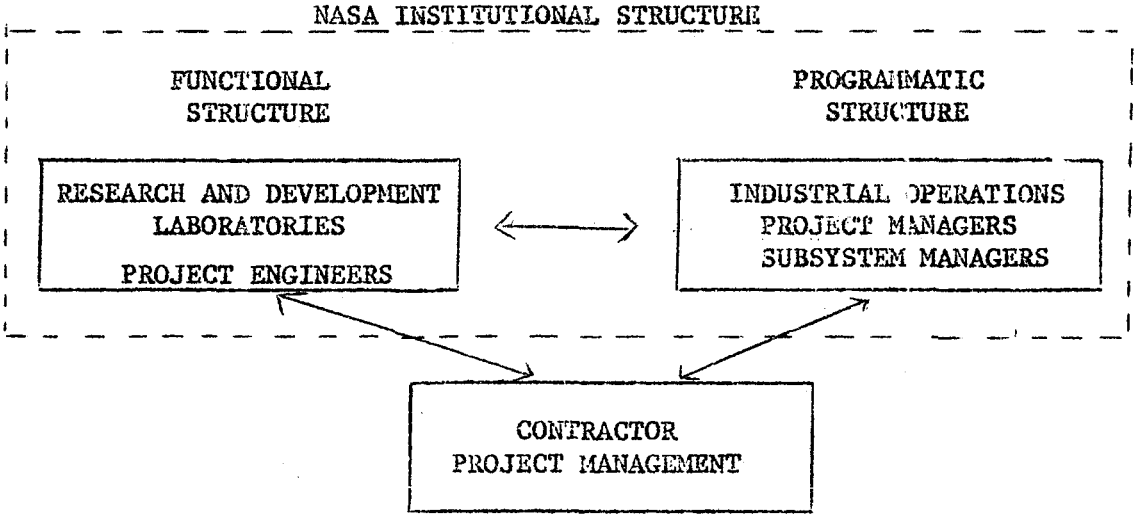

FIGURE 6 PROJECT MANAGEMENT, RESEARCH AND DEVELOPMENT, CONTRACTOR INTERFACES

Because of the complexity of the management problems in the Apollo Program a formal matrix identifying the formal interfaces between the IO subsystem managers and project managers and the R&DO project engineers has been established. It should be noted that these are only the formal points of contacts and that they also use an "invisible matrix". This develops out of personal friendships and alliances the project managers and subsystem managers have established. In many cases it is based on the type of problem that must be resolved and the engineers within the laboratories who have the expertise to resolve the problem.

The laboratories within R&DO operate on a "functional" basis. That is, each laboratory is organized around several basic engineering disciplines, i.e., the Astrionics laboratory, Aero-Astrodynamics laboratory, Propulsion and Vehicle Engineering laboratory, Quality and Reliability Assurance Laboratory, etc. In addition to supplying technical assistance to the Apollo program, the various laboratories are also engaged in various types of basic research. Specifically, the major functions of the R&DO laboratories can be delineated as follows:

1. To perform overall systems engineering for the Saturn Launch Vehicle Programs and to Provide scientific, engineering, manufacturing, test, quality assurance and managerial support to assure the successful performance and technical adequacy of the programs.

2. To perform complete engineering, development, manufacturing, test and program management for assigned subsystems.

3. To perform a continuing research and development program to provide engineering trade solutions, increased reliability, performance and usefulness of the Saturn Launch Vehicles.[12]

Perhaps the most unique difference between the Apollo Project Management Model and the others discussed is that most of the actual fabrication is done by contractors. NASA, in turn, offers a blend of management expertise, and technical skills and basic technology to the contractor. The meshing of the talents from both the contractors and from NASA distinguish the model from some of the others which have been previously discussed.

From an organization behavior perspective the Apollo Project Management model requires intensive coordination between NASA and the contractor. These requirements for coordination mandate that the participating organizations (NASA as the customer and the contractor as the supplier) literally integrate themselves in both a formal and an informal manner. Once the fusion process is established the two organizations can be conceptualized as a bi-organizational entity. The process is finite -- since it lasts only for the duration of the customer/supplier interface or for the contract period. The type of activities causing this fusion process are the formal systems, the informal systems, and the personal relationships among the NASA personnel and the contractor personnel. The fusion process is also fostered by the massive amounts of data and communication required and exchanged between the organizations.

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[12] National Aeronautics and Space Administration. George C. Marshall Space Flight Center, Apollo Program Management -- Volume 3. October, 1957, p. A-4.

The fusion process appears as a sign of organizational strength and flexibility. Management planners should not become concerned with it unless it impedes program objectives and the decision-making processes of both organizations. This fusion process is illustrated in Figure 7.

MANAGERIAL STRATEGIES IN THE PROJECT ORGANIZATION

It has been well documented that one of the chief criteria for project success lies in the leadership abilities and managerial talent of the project manager. Increasingly, governmental and industrial management planners are placing more emphasis on securing the right individual for heading a project task group. One researcher described the importance of project leadership in this manner:

> All of this recent research and experience underscores the fact that of all the factors contributing to the project success, none is as important as the leadership that the project manager provides to the effort. Study after study has shown without a high level of leadership, an abundance of all of the other favorable factors cannot make a project come in on time, within budget, and with a creditable technical accomplishment.[13]

It is rather difficult, if not impossible, to make generalizations about all types of project managers. However, various managerial styles can be delineated which apply to most project managers.

One of the most important leadership abilities a good project manager can have is the ability to communicate with other project team members. Recalling the statement made previously, a project group is

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[13]Robert D. Halverstadt and Richard R. Christensen, "From Project to Profit" Chemical Engineering Progress. April, 1966, p. 34.

BI-ORGANIZATIONAL FUSION

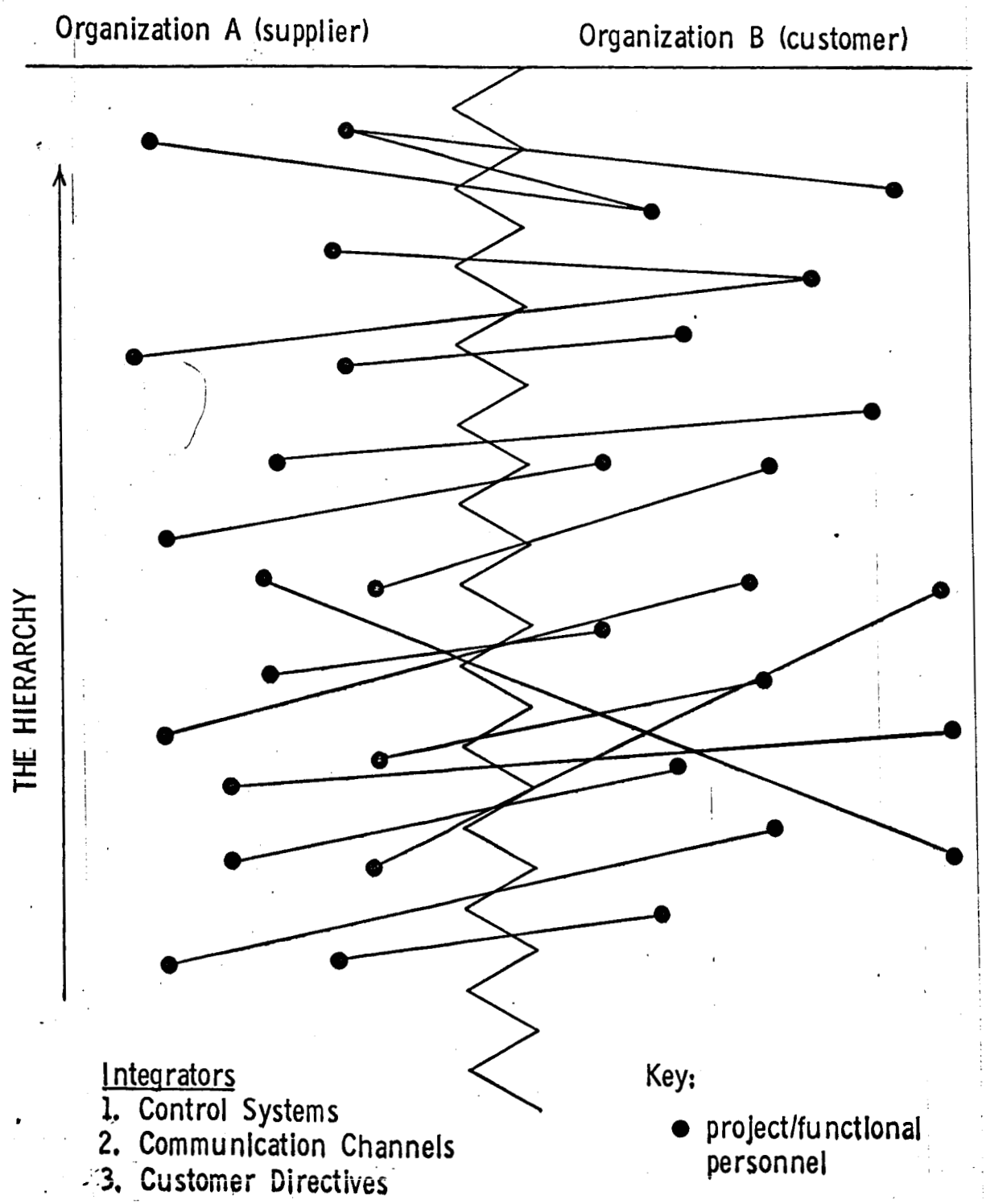

FIGURE 7

composed of several kinds of talents. For the larger project organizations, one could say that the project team is marked by the heterogeneity rather than the homogeneity of its participants. Consequently, the project manager has several diverse audiences that he must communicate with in terms of professional backgrounds and motivations.

Communication effectiveness is based in part upon the project manager's ability to perceive the differences in the way the various team members look at different situations which arise during the conduct of the project. If the project manager is able to comprehend these differences, then, he is better able to communicate his policies and stances on various project issues.

To illustrate the above point, let's use the example of the project organization within a governmental agency whose primary function is monitoring an industrial contractor. To help the project manager in his evaluative tasks, several laboratories within his organization provide technical expertise to the project manager to help him plan and audit the project's technical performance. In this case the basic responsibilities of the project manager are to have the piece of hardware produced by the contractor according to a specified schedule and within established cost objectives. The laboratory personnel of the Customer organization are only secondarily interested in cost and schedules and primarily interested in technical performance. The industrial project manager, by contrast, may be most interested in the profit incentives connected

with the project. We have, then, a situation where each participant on the project team views the "situation" differently. The project manager must understand these differences and orient his communications around these differences. Although each group contributing to the project may view the situation differently, the project manager must mold some sort of consensus from each "set" of project participants.

In project situations where the project manager has no direct authority over the project team members or it is defined, at best, ambiguously, the project manager's "personality" helps him penetrate and "work" the various functional organization when the need arises to mobilize men or resources for his project. The personality concept may include his ability to negotiate and build alliances with those who can help him in the conduct of the project. Although most project managers have to make "hard" decisions that affect various project participants and at times be autocratic in making decisions, he must, nevertheless, continually cultivate these friendships and establish various "spheres of influence" within the various contributing organizations of the project. Part of the difficulty of his position is that those who he must cultivate these alliances with are individuals that may perceive the project as a finite undertaking. The reciprocal relationship among the project manager and others may seem to them as temporary and not worth a great amount of investment of their own time and talents. If others within the organization perceive the project manager in this manner it may make the establishment and maintenance of alliances more difficult and tenuous.

One of the basic functions of project management which was alluded to earlier was to reduce organizational "red tape". Since the project organization is under the scrutiny of top management and various staff offices, there may be a tendency for various offices to slowly exert increasing degrees of control over the project organization. When the "system" becomes a hinderance to the project organization the project manager must devise ways to reduce the restraints of the system and still meet the requirements of top management. One method for reducing the impact of the various restraints of the project organization is by learning how to "short-circuit" the system. This involves finding out how the system works, what the demands of the system are and who is responsible for operating the system.

The first requirement, "Learning how the system works," involves careful study into the mechanics of the particular system, such as the "why" of the system, the priority it is given, how it is perceived in the hierarchy and what channels are used in getting the system from the project organization to those responsible for it and vice-versa. If the particular system is linear and is simply a feedback mechanism originating with the project organization and flowing to top management or various staff offices then the project manager may be solely responsible for inputs into the system, consequently, he is directly accountable for the inputs. However, if the particular system is an "open-system" and the inputs

of several individuals in different organizations are required, then, the project manager's role as a participant in the system complex may take on a different perspective. Part of his function in "working" the various systems may be based on what use is made of the various systems. For example, in one case encountered, a PERT reporting system had been perfected to such an extent that the output of data was so extensive that it was virtually unusable. In this instance, little use was made of the reporting system by top management, by the staff or by the project manager.

The second variable affecting the project manager's perception of systems involves determining who is responsible for managing the system and what his objectives are for the system. Some systems are initially established for specific reasons and for a finite duration. Nevertheless, once they become attached to the project organization it may be difficult to have them terminated although their functional use has been fulfilled. Project managers perceiving a situation such as this must learn to place low priorities on the system.

SUMMARY

The objective of this paper was to present an overview of several important characteristics of project management. With the evolution of new technologies and the demands they place on organizations we shall undoubtedly see an increased use in several new management methodologies - especially project management. This paper has attempted to describe some of the unique relationships found in project organizations as well as analyze the rationale behind them.

Several forces at work within and external to today's organizations were cited as having great influence on the development of new organizations. Such forces have caused management to reappraise their thinking regarding the nature and functional requirements of organizations. Project management is a problem-solving system which has been an outgrowth of this period of reappraisal.